Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 2 (2010) 650–655

Procedia Environmental Sciences

International Society for Environmental Information Sciences 2010 Annual Conference (ISEIS)

A Gis-Based Decision Support System for Water Trade Management of River Basin Cities

G. Z. Zhang[1]*, W.N.Zhao[1], H. Liu[2]

1 School of Environmental and Municipal Engineering, Lanzhou Jiao Tong University, Lanzhou,,730070, China

2 Centre forStrategic Environmental Assessment, Baotou Municipal Research Academy of Environmental Sciences, Baotou,014010,China

Abstract

With the growth and formation of the river basin for several thousand years, a series of cities were formed along water basin. The activities arising from the upstream and downstream cities such as water intake and wastewater discharge significantly affect the nature of the river. These cities are called “The Basin City”.

A GIS-based decision support system (DSS) was developed in this paper for water trade management of basin cities in order to investigate water trade mechanisms. Several subsystems are included in the developed DSS, i.e., data-driven subsystem for predicting the change of water quality and water volume which will be used for water quality assessment and pollution control purpose; basin information subsystem; trading information subsystem, a ranking subsystem for water environment management; a information subsystem including various standards, laws, regulations;spatiotemporal relations of water attributes etc.All of these subsystems benefit the sustainable management of cities along the study river and water basin.

The GIS-based management of the basin city water environment was a multi-objective and hierarchical comprehensive DSS. The change of basin water resources and the using situation together with the pollution discharge of from cities along the river can be observed visually, intuitively, and rapidly. It is a platform for the basin city water trades and a water resources transaction system.

Keywords: GIS;Water trade management;iver basin cities

1. Introduction

With the rapid development of human socioeconomic, environmental pollution has become more and more constrained economic and social development and an important factor in human survival. The problem of environment has become a hot research concerns and difficult issues.

In the long history of development of human society，the most basic law of survival is to live along river basin. A series of river basin city was formed with the development and improvement of river basin in thousands of

* Corresponding author. Tel.: +86-931-493-8165; fax: +86-931-493-8165.

E-mail address: zhangguozhen@mail.lzjtu.cn.

doi:10.1016/j.proenv.2010.10.073

years. The water using for living and production of these cities is taken from the basin and cities' waste water has discharged into the river basin generated in the basin.So river basin is the source of life in these cities, also accepts the cities'environmental waste. River basin from upstream to downstream is inter-related, forming a self-contained and an integral symbionts. These cities along the river basin are called "River Basin Cities". Water trading and emissions trading of river basin cities base on a single trading platform integrated for trading, because water supply and drainage are in the same river basin.This is the article refered that river basin cities water trading mechanism.

There are a variety of relevant systems with the current extensive use of GIS. Such as natural resource management information system, resource and environmental information systems, land resources information systems, spatial data processing systems, spatial information systems and so on(Li,2003). The subject of GIS for integrated river basin environment have also been more researched. For example, groundwater quality assessment by using geostatistics based on GIS(Zhou et al,2008),review of the technology of distributed physical models system for simulating geographic processes(Zhao et al,2006),design of an early warning system of water security for liaohe river based on GIS(Wang et al,2007),GIS-based research of water environmental management decision support system in Tongchuan new-district(Ruan et al,2004).

To solve a series of questions of the shortage of river basin water resources and water pollution, this article tries to establish a GIS-based decision support system for water trade management of basin cities. That is combining the GIS system and the river basin water rights trading market and emissions trading market. This will optimize the allocation of water resources, control pollution emissions, increase environmental performance, ease of transactions and water management and promote the development of economic collaboration and water environment.

2.The Design Of The GIS DSS for Water Trade Management

2.1 The overall goal of The GIS DSS for watertrade management of basin cities design

The system will use the the spatial data management of GIS ,storage basin cities water environment-related data and model to analyze these data to judge basin cities water environment carrying capacity and so on. According to the above ,the trading model of water trade management of basin cities is established; a dynamic river basin management of water environment is achieved;basin pollution water planning control and decision-making visualization and quantitative. science of river basin water are achieved.

According to the information of timely and accurate real-time monitoring of the pollution location, pollutant emission concentration and speed diffusion of pollutants, the system will take effective measures to control the spread of pollution of basin water systems, reduce the impact of watershed and restore the normal operation of basin water systems.

After the GIS-based decision support system for water trade management of river basin cities is established, it will make date of the changes in basin cities water resources, river basin cities water use situation and river basin cities sewage situation and establish a huge database platform of the river basin cities' clear right to the sewage and water tradement.This will enable river basin city water use and pollutant emissions marketable, rational use of water resources ,effectively control the emission of pollutants and achieve the purpose of coordinated development of economy and environmental protection.

2.2 Functional Design of The GIS DSS for water trade management of basin cities system

The system will monitor and manage water resources in real-time trading information services under the specific requirements of basin cities water trading.The GIS systems to support the use of database management technology and network programming tools will carry on real-time monitoring of water resources and manage of water resources monitoring assessment, forecasting, trading and management.The GIS DSS for water trade management of basin cities should include the following function modules:

(1) the basic information of riverbasin cities and water resources

This includes basic information of river basin monitoring stations, the main river, major water users, geographic information of sewage units, status of water resources and other information.

(2)inquiry the various types of monitoring information of river basin cities

This will provide the inquire collection monitoring information of the distribution of various types of monitoring in the entire basin river cities,such as rainfall, runoff, water quality information and so on.And also this will provide overlooking real-time information of single site,queriong a process of river basin cities and displaying the spatial distribution in a period of time of some indicators.

(3) river basin water resources assessment information querye

Using time series data of the database,it can evaluate a target (such as runoff, sewage volume)at a time, compare the state of its multi-year average and get cnclusions by the relative position.

(4) river basin water resources management

A special government river basin water management should be established.This management will achieve integrated management about the water and groundwater resources of basin cities,water resources and water resources of rural areas and basin areas, basin and rural flood control, water storage, water supply, water and sewage treatment and so on.At the same time the management will determine the basin water resources that the river basin cities can deal and achieve reasonable development and utilization of river basin cities water resources.

(5)river basin management of the initial water right allocation

The river basin cities management by the government plans profiles the initial water rights, including the city's agricultural water basin, industrial water, environmental water allocation of water rights, etc.All of these lay the foundation for river basin water trading.

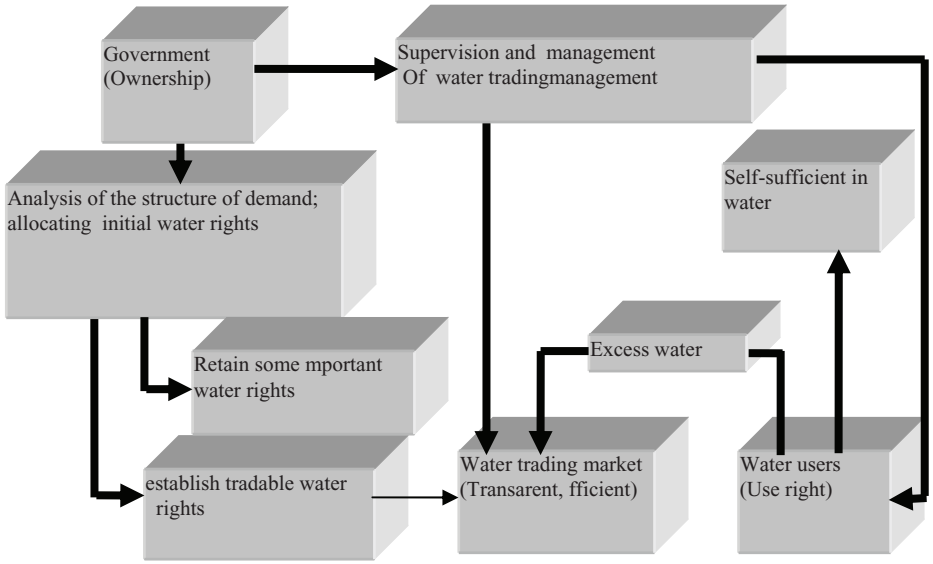
(6)registration of water rights, management, property protection and public announcement system management

Government management of river basin water resources register the cities' water trading information, and make trading parties legal protection for the use of water resources. They make a notice that the main extra on their water rights of water right transfers to facilitate the transfer of water rights.

(7)river basin water right trading platform

This platform includes river basin water rights trading, emissions trading, the river basin city user information etc and the formation of water trading network which is by the river basin water resources management department of the government operation and management.Building the internet platform for trading in water rights on the basis of water price protection, water right price mainly is adjusted rely on the basic role of water resources in the market . Water users visit the web site, view the water right transactions and contact other water users with excess water rights according to the internet published information. After the deal intention, buyers and sellers of water common commiss the water right company transactions in accordance with the specific format about water quantity, price and other terms of the transaction. After the company making an initial review of water right and demonstrating in detail and approved the water right information, the compangy report to the public aboutWater trading information. The two sides of the contract of sale are effective immediately such as social no objection .The water trading patterns as shown below Figure 1:

Figure 1 Mode operation of water trading



(8) river basin water rights transaction information query.

Transaction information includes: total water availability, the user water distribution, total available volume of sewage, discharge of all users assigned amount, the price of water and sewage of the user and the industry unit, the tradable regional scope,tradable water and sewage volume, tradable emission content and so on.Transaction information generats from the results database by running the model subsystem.

(9) basin water right trade supervision and management.

Specific management process carry out in the model subsystem. Model subsystem optimize the management of computing the results stored in results database.The outcome of optimal management of information is searched in query subsystem.

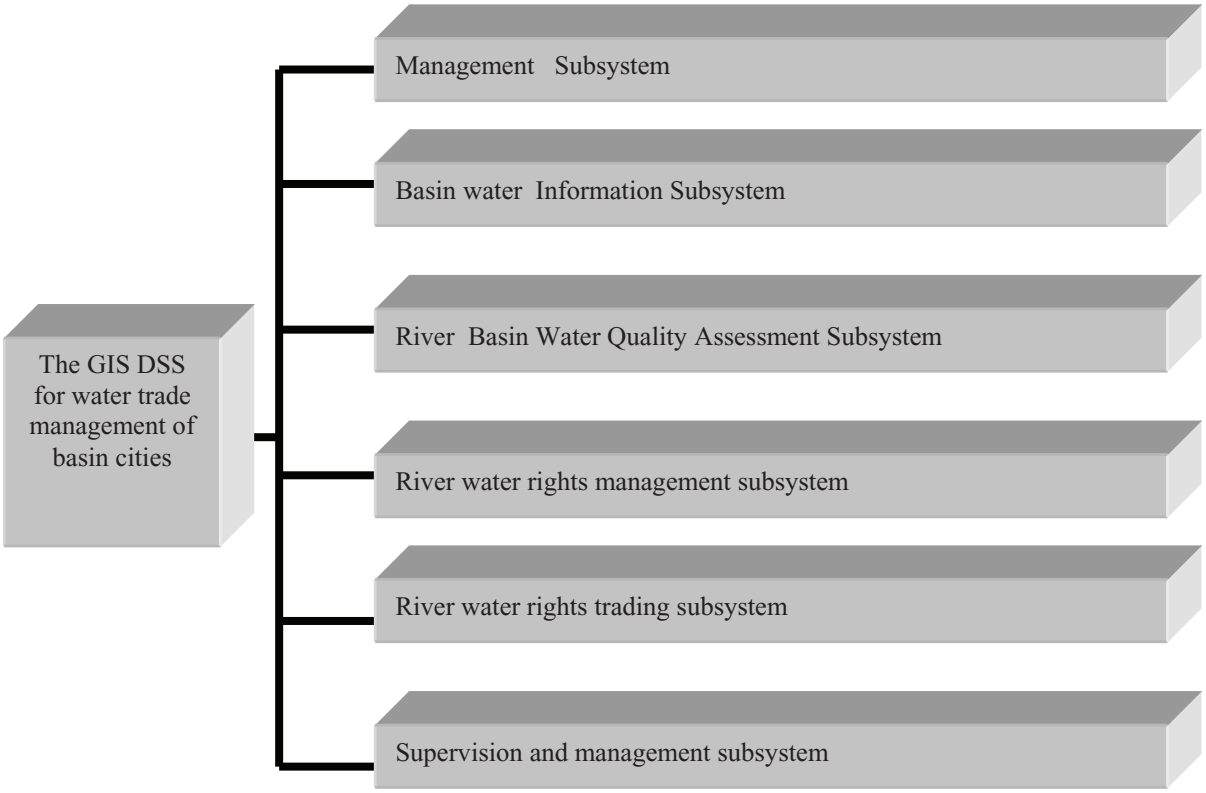
(10) river basin water trading management system of laws and regulations

These below will be formulate:basin water right trade related laws and regulations;trading rules for water trading and other relevant laws and regulations.These provide legal protection about the parties,make the smooth transaction of river basin water rights and basis for a legal framework of emissions trading toriver basin water rights.

2.3 Logical structure of The GIS DSS for water trade management of basin cities

The GIS DSS for water trade management of basin cities system set the data processing information on basin water resources and river basins, the sewage situation information, the river city trading platform and information in one system.The structural framework of GIS DSS for water trade management of basin cities containing System functions from the above proposed is showed in figure 2.

Figure 2 System structure



2.4 System Database of The GIS DSS for water trade management of basin cities System

Database is a core component of Geographic Information System.The setting up and effectiveness organization of the database will play a decisive role in the the GIS system operating Successfully(Wu,2002).

Database design of Trading of water rights philosophy:

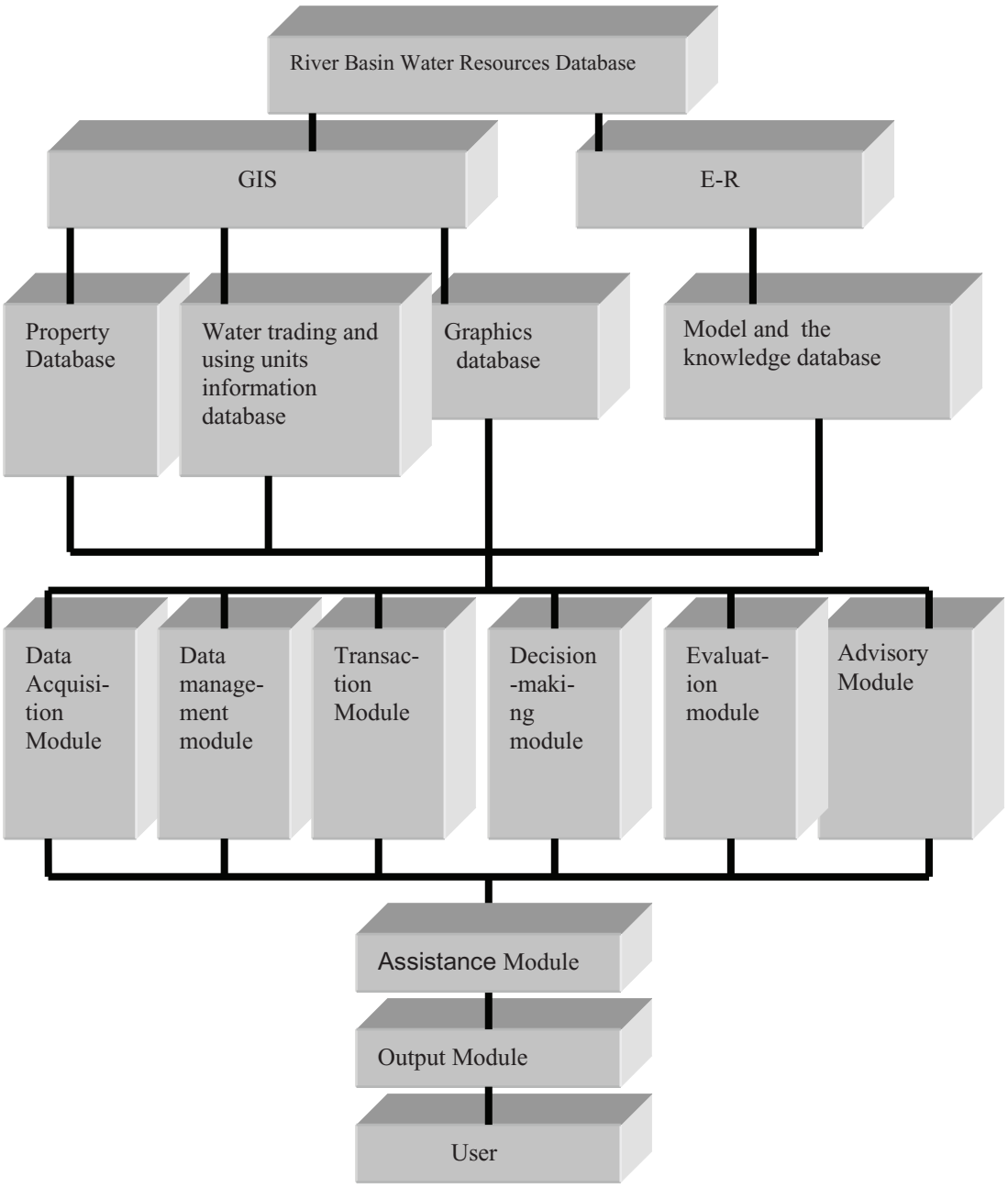
(1)Using of GIS to realize management the graphics data.Water rights transactions database includes attribute data,such as water type,code,water quality information,information on various water quality monitoring stations; also includes graphics data,such as water distribution,the use units of basin water right distribution maps,basin city sewage units distribution maps,etc.

(2)Using of ER model (Entity - Relationship model) to achieve model-based reasoning and knowledge decision-making.The capabilities of water advisory the right trade at all levels of users, real-time transactions and decision-making is implemented through the establishment of water quality model base and knowledge base to achieve.

The structural design of the Water trading database design:Basin Water right trade database structure and function as shown in figure 3.

The database is composed by the eight sub-databases: river basin water type sub-databases;water resources sub-databases; water resources management sub-databases;information of unit using water rights sub-databases; water trading information sub-databases;model sub-databases;knowledge sub-databases.

Figer 3 Basin Water right trade database structure



2.5 Development and Implementation of The GIS DSS for water trade management of basin cities System

The GIS DSS for water trade management of basin cities system is an open system for more business and managements.It can achieve goals of management of the river basin water resources,all levels of transactions user, water rights trading;transaction information queries for all levels trading user of water rights;transactions and other related functions.It is better for real-time monitoring and management of water resources monitoring, assessment, forecasting, trading.

The developed system uses VISUAL BASIC + WebGIS development model,storing data by VB database management system. System development platform is provided by VB programming language;GIS using VISUAL BASIC as a development platform, the system defines and generates the geographic graphic attributes of river basin water resources by MAPGIS, using the MAPGIS control to achiving geographic information the query and control.

To realization the smooth,stable,and safe river basin water trading,it is used GIS component for integrating development.WebGIS technology architecture can be achieved with the following features:the ability to share multiple resources,water resources,property characteristics;Through using the Internet protocol standards,water trading users with the identify account are allowed to search water rights information in any place online water trading; system supports data distribution and decision-making,by monitoring the status of river basin water resources and changes in the citis,timely adjust of water rights transactions,control the total discharge of pollutants within the catchment to ensure the basin's water resources and of the ecological environment balanced development as well as other important functions.

3. Conclusion

A GIS-based decision support system for water trade management of river basin cities is a multi-objective, hierarchical and network model.After the GIS-based decision support system is established, it will be intuitive,fast, effective and reflect the changes in water resources and sewage of river basin water use situation.At the same time the system will establish a clear, accurate platform for the formation for river basin cities water trading t transaction;eventually will make basin water use and pollutant emissions market, rational use of water resources , effective control of pollutant emissions, achive purposes of economic and environmental protection coordination development, so that river basin cities develop sustainablely.

Acknowledgements

Financial supports from the National Key Technology R&D Program（2006BAJ08B08-03）, the National Key Technology Specific Project-Water Contamination Control and Government（2008ZX07425-005）,the Key Technology R&D Program of Gansu Province（JK2007-21）.

Reference

[1]Li Xuxiang. *GIS in Environmental Science and Engineering* [M].Beijing：Electronic Industry Press;2003.
[2]ZhouXiaohong,LiXiaojuan and GaoCunrong.(2008).Groundwater Quality Assessment by Using Geostatistics Based on GIS. *JournalofCapitalNormalUniversity(NaturalScienceEdition)*. 8 (4): 25
[3]ZHAO Hanbing, ZENG Zhiyuan, HU Yueming.(2006).Review of the Technology of Distributed Physical Models System for Simulating Geographic Processes.*Journal of Agricultural Mechanization Research*. 10,37-42
[4]WANG Geng, WU Wei.(2007).Design of an early warning system of water security for Liaohe River based on GIS.*Journal of Dalian University of Technology* . 42（7）:175-179
[5]RUAN Shiping,DANG Zhiliang,HU Xiao- han,MA Fei,ZHANG Mengtao.(2004).GIS- based Research of Water Environmental Management Decision Support System in Tongchuan New-district.18（5）:38-42
[6]Wu Xincai.Principles and Methods of Geographic Information Systems [M]. Beijing：Electronic Industry Press.2002.